# Mercurius MK-V Active Closed Loop Extractor User Manual

BUILDING VISION AND VARIETY

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## Introduction:

The Mercurius Active closed loop is intended to perform hydrocarbon botanical extraction within a sealed system. Rack mounting provides ease of work, eliminating heavy lifting associated with operating large capacity units of the past. Using a combination of jacketed columns, condensers, and solvent evaporation, temperatures can be controlled throughout the system to ensure the highest clarity extract is achieved.

Here are some features that make running the Mercurius active so efficient.

- Rack Mounting
- Bi-Directional Solvent flow
- Active Recovery for both collection and material column
- Hot Vapor Loop
- Jacketed collection base
- Dual condensing for efficient recovery

### General Uses and Extraction Information

Hydrocarbon extraction is performed by passing an alcane solvent over an organic material to separate terpenes and other hydrocarbon compounds. Solvent is then distilled to leave the extracted compounds behind. The Mercurius is an active closed loop, so solvent is moved with a combination of temperature manipulation, as well as pump assistance. This system is intended to be run with 100% butane (R-600) or iso-butane (R-600a)***. Solvents always seek the lowest pressure in the system. By chilling the receiving vessel below the boiling point of the solvent used, the liquid solvent will seek that vessel to reduce its pressure.

***If propane(R-290) is to be used, inline sight glasses must be removed from system.

### General Safety Information

When operated and maintained according to the directions in the manual, common practices and safety procedures, the Mercurius Active system should provide a safe and reliable extraction process. This unit should be run only in extremely well ventilated areas. If running the unit indoors, it must be operated in areas approved by local fire marshal, in accordance to local and state laws/ordinances. Always pressure check system prior to every use. Make sure all gasket seals are cleaned with compatible solvents, and checked for wear before each use.

**The Mercurius Active system uses flammable solvents. Use EXTREME caution while operating unit. ALWAYS OPERATE IN EXTREMELY WELL VENTILATED AREAS**

**Vacuum Pump is to be located OUTSIDE of extraction room, with hosing piped through the walls. NEVER use pump when flammable vapors are in present in system.**

## Preparing to Extract

Before you begin, you are going to want to make sure you have the necessary supplies to run the unit. Here is a list of some things that will be needed to operate the unit.

- Tools (various wrenches/sockets)
- Dry Ice
- Alcohol or Glycol for condensers
- Butane
- Nitrogen gas cylinder with regulator
- Refrigerant scale
- Combustible Gas Leak Detector (recommended)
- Explosion-proof exhaust fan (recommended)
- Cleaning solvent (D-limonene is recommended)

Once the machine is packed with material and assembled, always pressure test the gasket and clamp connections. Pressurize the entire unit to 90 PSI with nitrogen gas using the vacuum valve. Allow pressure to sit for at least 10 minutes, checking to make sure no pressure is lost. If the unit is sealed, connect vacuum pump to manifold and pull a full vacuum.

**Always tighten clamps evenly on each side. Unit MUST be pressure tested to 90 PSI before each use. Failure to do so could result in solvent leaks.**

## Manipulating Thermals

In order to move the solvent through the system, you must ensure that the supply vessel is of higher pressure than the receiving vessel. This can be achieved by making sure the receiving vessel is colder than the supply vessel. Temperature is pressure, so maintaining a temperature gradient to transfer solvent within the system is important.

Even though this system is intended to be run active, it is still very important to practice passive tech. We want to ensure the temperatures within the system are set so it could recovery passively, and the mechanical force of the pump is simply used to aid recovery.

The best way to maintain control while operating an active system is to use passive tech. If coil and condenser temperatures are significantly lower than solvent boiling point, solvent will maintain liquid state and pull a

vacuum on itself. If temperatures will not allow this negative pressure, the pump will always be fighting this opposing pressure.

If you refer to (fig. 1), you can see that solvent pressure is directly related to its temperature. As the solvent increases in temperature above the boiling point (*fig.2),* pressure will increase. Alternatively, since we are working in a system that is at a full vacuum, as the solvent gets colder than the boiling point, pressures will start to go into the negative.

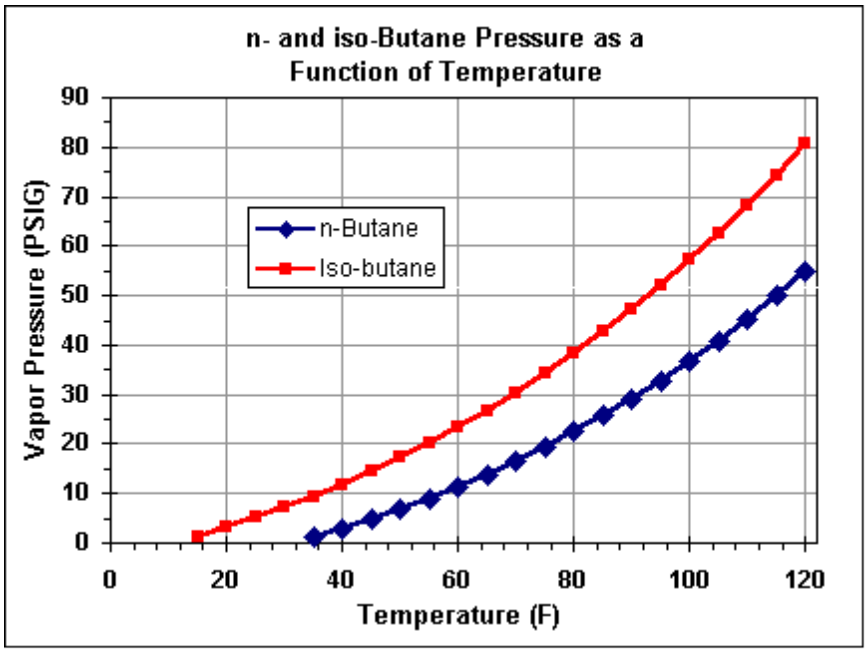



*FIG. 1*

| Solvent | Boiling Point |
|---|---|
| n-Butane (R-600) | 30.2 °F (-1 °C) |
| Isobutane (R-600a) | 10.94 °F (-11.7 °C) |

*FIG. 2*

When distilling the solvent in the collection, it is important to note the boiling point of the most delicate compound in your extract; *i.e. when extracting hops or rosemary, your recovery temperature should not exceed the boiling point of your lowest boiling terpene, Beta-caryophyllene. It is important to note that boiling points decrease as the level of vacuum increases. The change in boiling points can be calculated using the Clausius Clapeyron Equation. For B-caryophyllene,*

- *[246.2°F @760torr (-0.00in.hg) 0% vac]*
- *[180.00°F @100torr (-25.98 in.hg) 87% vac]*
- *[159.99°F @50torr. (-27.95 in.hg) 93.5% vac]*
- *[138.82°F @23.4torr (-29 in.hg) 96.9% vac]*
- *[109.44°F @7.6torr. (-29.62 in.hg) 99% vac]*

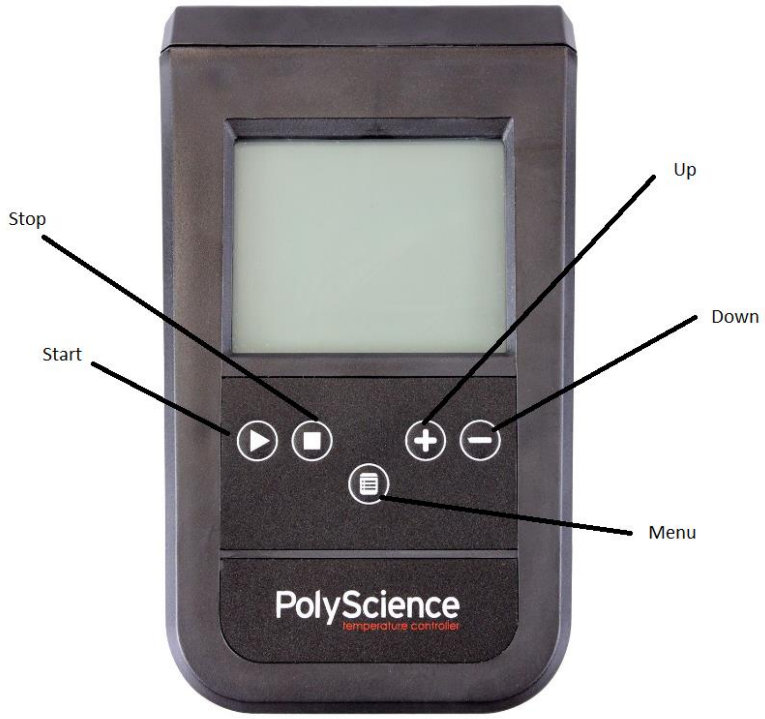
By keeping the warm water bath below the boiling point of the lowest boiling compound, you are able to preserve the full spectrum of your extract.

a. Using Circulatory Pumps

The Mercurius Active system uses a jacketed collection base. In order to manipulate thermals within the collection, a chiller or circulation pump and heat/cold bath is required. It is recommended to use a dry ice and propelyne glycol bath for the cold end, and a water bath with an immersion heater for the warm. To use the pump, simply submerge the pump in the chosen temperature bath, or use the siphon line configuration. Please refer to the instructions provided with the pump to get further information on the pump.

b. Using Immersion Heater

In order to maintain the warm bath for recovery, the use of an immersion heater is required. It is recommended when operating the Mercurius system to use a Polyscience LX Immersion Heater. This heater is simple to use, and helps make recovery quick and efficient.




Use the Menu button to set to Fahrenheit or Celsius, then set temperature.

Once a set temp is made, press the start menu to start heating and circulation.

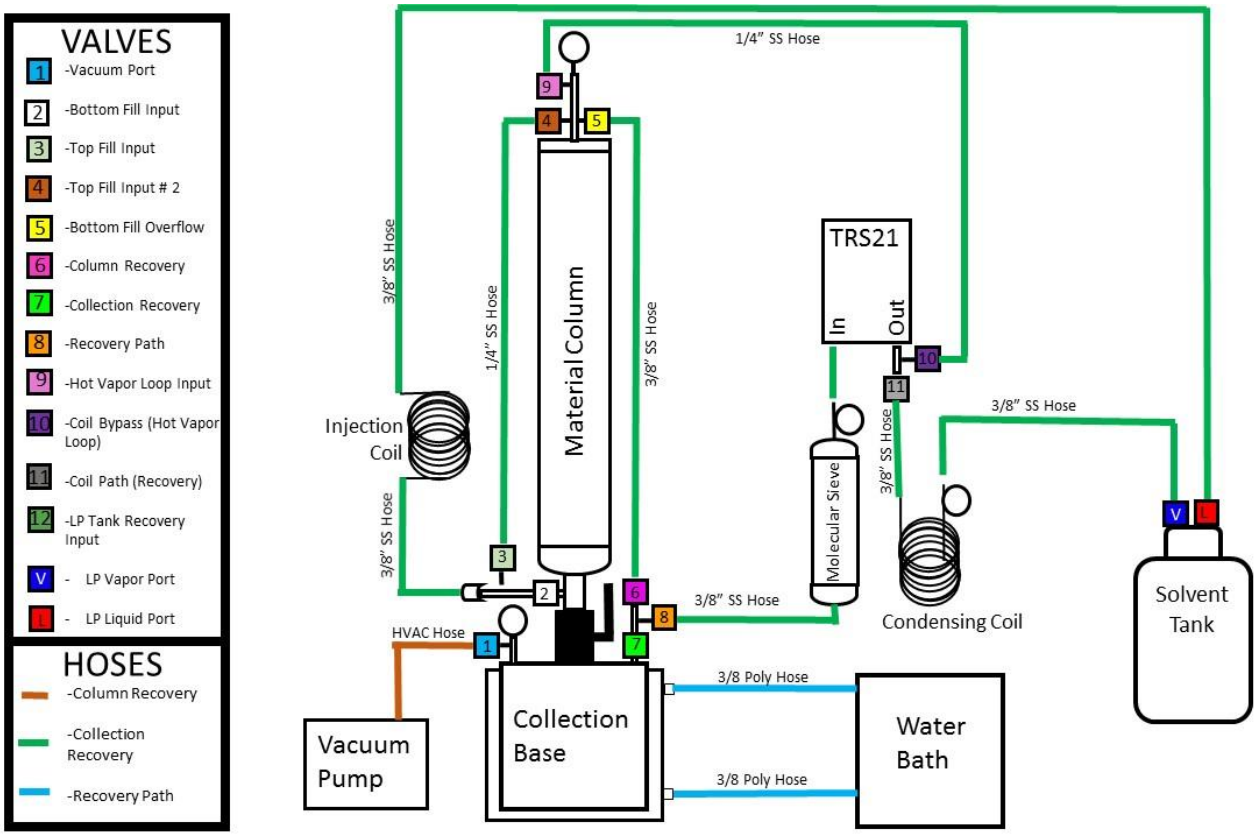
It is recommended to set the temperature 5 to 10 degrees warmer than your intended recovery temperature. This will accommodate temperature loss when switching from cold to warm.

**Controls and Components**

a. Valve/Hose Layout

The valve layout and hose configuration is listed in the diagram below. Hoses diameters are listed below.

b. Active Recovery Set-up




The Mercurius Active closed loop extractor comes standard with an active recovery set up. This consists of a molecular sieve, recovery pump, condensing coil, and LP tank.

First, let's start with the molecular sieve. This rack mounted column features two hemispherical reducers, 5 micron filter screen, and desiccant beads. These beads absorb moisture from solvent vapors during recovery. It is important that the moisture absorption of these beads is monitored, and they are regularly refreshed. (Bake beads in oven @300 F until blue indicating beads restore to original color). The 5 micron filter screens prevent dust from the desiccant beads from transferring into pump and LP tank.

**ALWAYS CHECK THAT SEIVE HAS GASKETS INSTALLED BEFORE FIRST USE.**

A heat jacket can be installed on the molecular sieve to prevent condensing of solvent inside the sieve. This can also be used to increase incoming pressure of the recovery pump.

The recovery pump is used during recovery to add a mechanical assistance to passive solvent recovery. This is used to help regulate pressures and speed up recovery. The recovery pump also features a coil bypass which is used to manipulate pressure and temperature of the material column.

The final stage of the active recovery system is a condensing coil. This ensures solvent vapors are efficiently condensed and chilled, allowing solvent pressures to be reduced.

## Start-up and Operation:

In this section, we will cover pre-run procedure and the operation of the Mercurius Active system. It is important to have your tools on hand at all times (wrenches, scales, buckets). When setting up the unit, it is recommended to position all clamps with the same positioning, if possible. This ensures continuity if adjustments are needed during operation.

Always make sure your system is positioned on a level surface with adequate air flow. Butane is known to pool in cool areas, so it is important to ensure no areas of stagnant air flow exist in the workspace. If operating indoors, it is important that your workspace meets the criteria for a Class I, Division 1 work environment. Please consult your local fire marshal to ensure workspace is in accordance to local laws/ordinances.

**Before beginning the first run, it is important to heavily clean all gear. Oils and metal shavings from manufacturing, as well as warehouse and packing dust can potentially be on all equipment. Failure to do so can result in contaminated extracts.**

**<u>Pre-Run Procedure/Testing</u>**

Pack material column with your chosen organic material, then assemble each column as pictured above. Always check that fasteners on rack are tightened before each use. Make sure all filter screens are in place and filter plates have a coffee or lab filter in place. *(Coffee filters are 20micron)*.

The Mercurius Active is intended to be packed with dry material. **Wet or damp material can be run with proper pre-run processing and additional nitrogen purging. Care must be had to maintain subzero temperatures during this type of extraction*** System capacity is figured at 4.2 g/in3. *Capacity may vary depending on material/packing density*. It is recommended to give a firm pack; a loose fill of the column will allow solvent to pass over the material too easily.

After unit is fully packed and assembled, attach nitrogen cylinder to manifold and perform pre-run pressure testing.

Every time you assemble your Mercurius Active system, it is vital that the system is pressure tested to **90 PSI with nitrogen gas**. This ensures all clamps/gasket and hose connections are sealed. Make sure all valves are in open position during testing. Allow pressure to sit for at least 10 minutes before releasing pressure and pulling system to a full vacuum.

**Always check high pressure nuts and bolts for wear and tear before each use. It is recommended to have spares on hand to prevent down time. Failure to maintain clamps can result in unexpected clamp failure.**

When no loss in pressure is observed, release nitrogen pressure. Disconnect nitrogen cylinder from vacuum port and connect vacuum pump.**If you have a diaphragm pump, use this to pull nitrogen pressure out instead of releasing to open air. This prevents moisture from atmosphere from re-entering machine*** Allow unit to be pulled to a full vacuum, using the multiple pressure gauges to ensure full negative pressure is achieved. When completed, the vacuum pump can be put away until next use.

**Before you begin adding solvent into the system, it is it is important to pre-weigh solvent in the LP tank to ensure the system is not overfilled. This also enables solvent to be re-weighed post extraction, ensuring all solvent has been recovered.**

The solvent capacity of n-Butane of the Mercurius active is determined by the size of the collection base.

*Solvent capacity at 80% fill***

**10” x 10” – 12 lbs.** **12” x 12” – 24 lbs.** **12” x 24” – 48 lbs.**

**Utilizing Solvent Evaporative Cooling**

The Mercurius Active system is set up to utilize the evaporative cooling properties of our hydrocarbon solvents. To quickly summarize what this means, solvent is feathered into the material column, just enough to ensure that all of the material has been slightly saturated. Once the material is gently wetted, force recovery of the column from the column recovery path. Once a vacuum is restored on the column, the material and column will freeze.

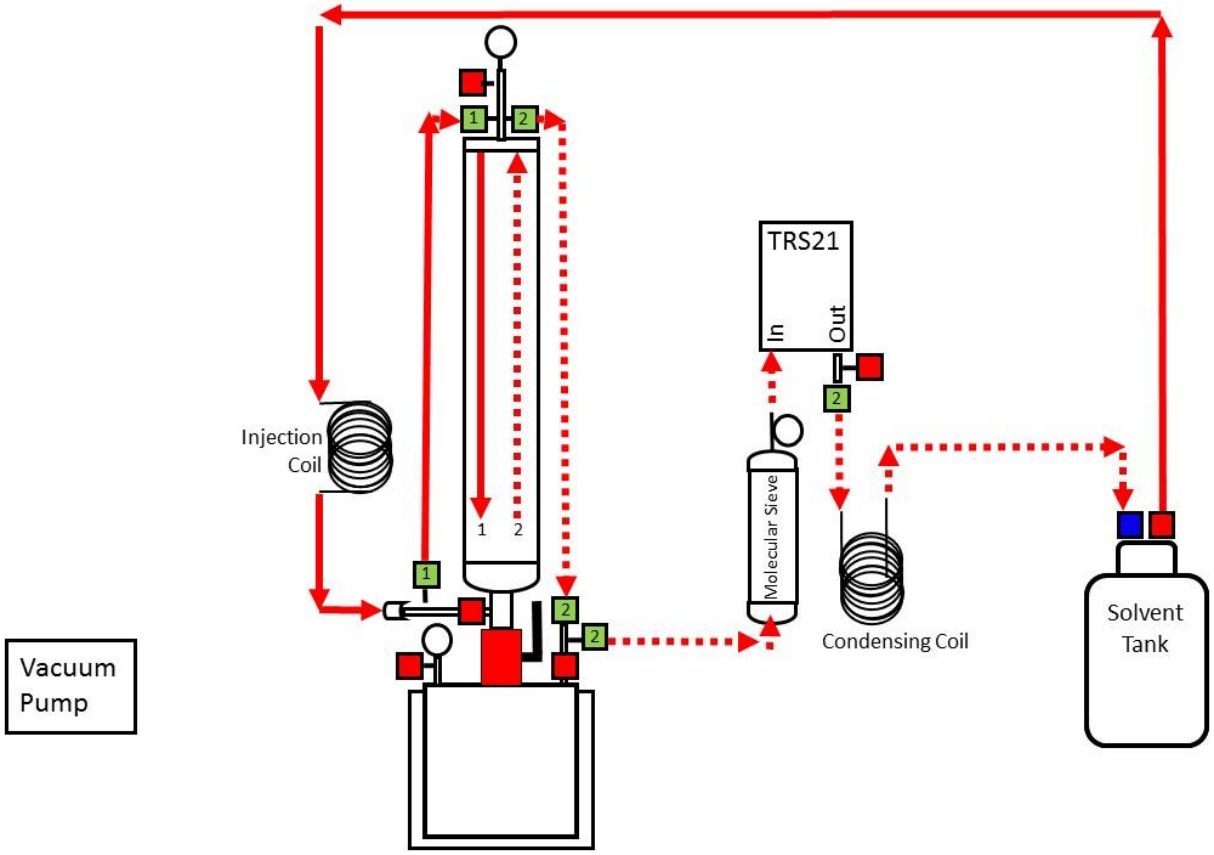



*FIG. 4*

The diagram above (fig. 4) shows a two-step flow of how this is performed. Red blocks indicate closed valves, green signifies open. During path 1, valves numbered 2 are closed, vice versa.

First start by opening the liquid port on LP tank, then follow path one. Use the top flood input valve to gently feather solvent into the material column. The aim is to only allow enough solvent in to wet the material. The inline ball valve can be opened so sight glasses can be used as an aid when learning.

**If this method is used, stop flow the moment any solvent is seen hitting collection base. Too much saturation will hinder the process***

Once the material column is saturated, close valves marked one, as well as the liquid line on the LP. Open valves marked 2 and the vapor port on the LP, then start the Recovery Pump. The mechanical pull from the pump will force a phase change on the solvent, turning liquid into vapor. The resulting vapor will be recovered. As the phase change occurs, latent heat from all surfaces touched by solvent will be removed, instantly freezing the material column. This change will occur once all pressure is relieved from the column, and vacuum returns.

**Adding Solvent to the System**

Connect LP tank to the solvent input manifold (*please refer to assembly diagram)* using the short ¼" SS line. It is recommended to connect the liquid valve (red handle) to the manifold. This port contains a dip-tube, so the cylinder must be upright to empty liquid solvent.

a) Bottom Flood Input:

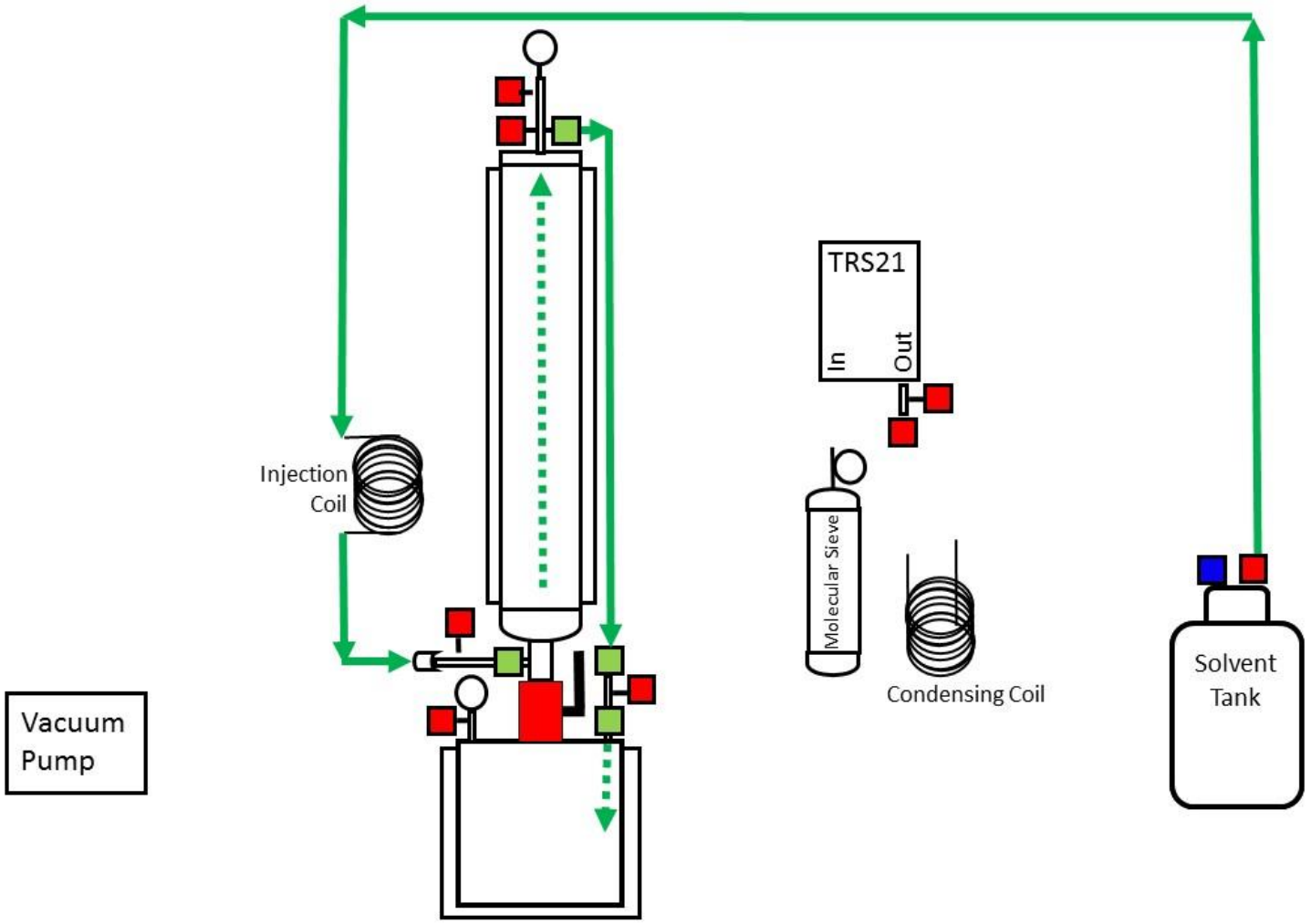



*FIG. 5*

The first pass of solvent is recommended to be done from the bottom flood input (both valve handles on manifold are in the horizontal position). This ensures that all material is exposed to solvent. The bottom flood overflow valves are open (as shown above). **Before solvent is entered into the system, the Injection coil should have a dry ice/alcohol slurry added to the bucket.** This will prechill solvent for efficient dewaxing. As solvent is entering column, place hand on the 3/8" overflow line. When solvent reaches the top of the material column, the overflow line will vibrate as liquid flows through. This indicates the entire material column is full of solvent; at this point, close off the overflow valve and allow a slight saturation of the material.

b) Top Flood Input:

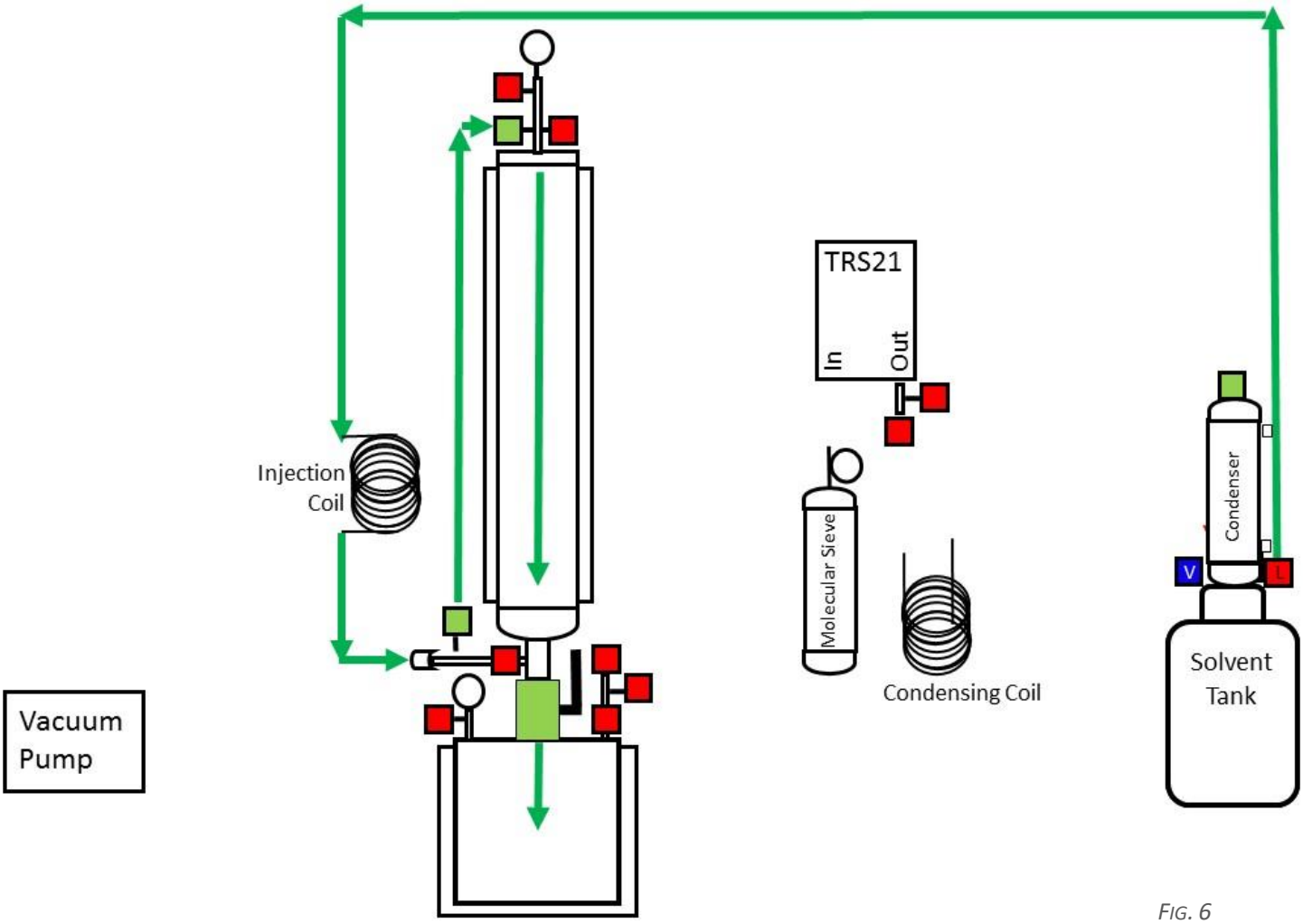



*FIG. 6*

After the bottom fill overflow valve has been closed, switch the solvent input manifold to the top flood position(valve handles both in vertical positioning) then open the inline ball valve. Extract bearing solvent will flow from the material column to the collection base. Leave the ball valve open until solvent flow ends.

**To aid solvent movement to the collection base, it is recommended to recirculate a chilled fluid through the jacket. This helps minimize pressures and aids in preventing vapor locks.**

**Utilizing Hot Vapor Loop:**

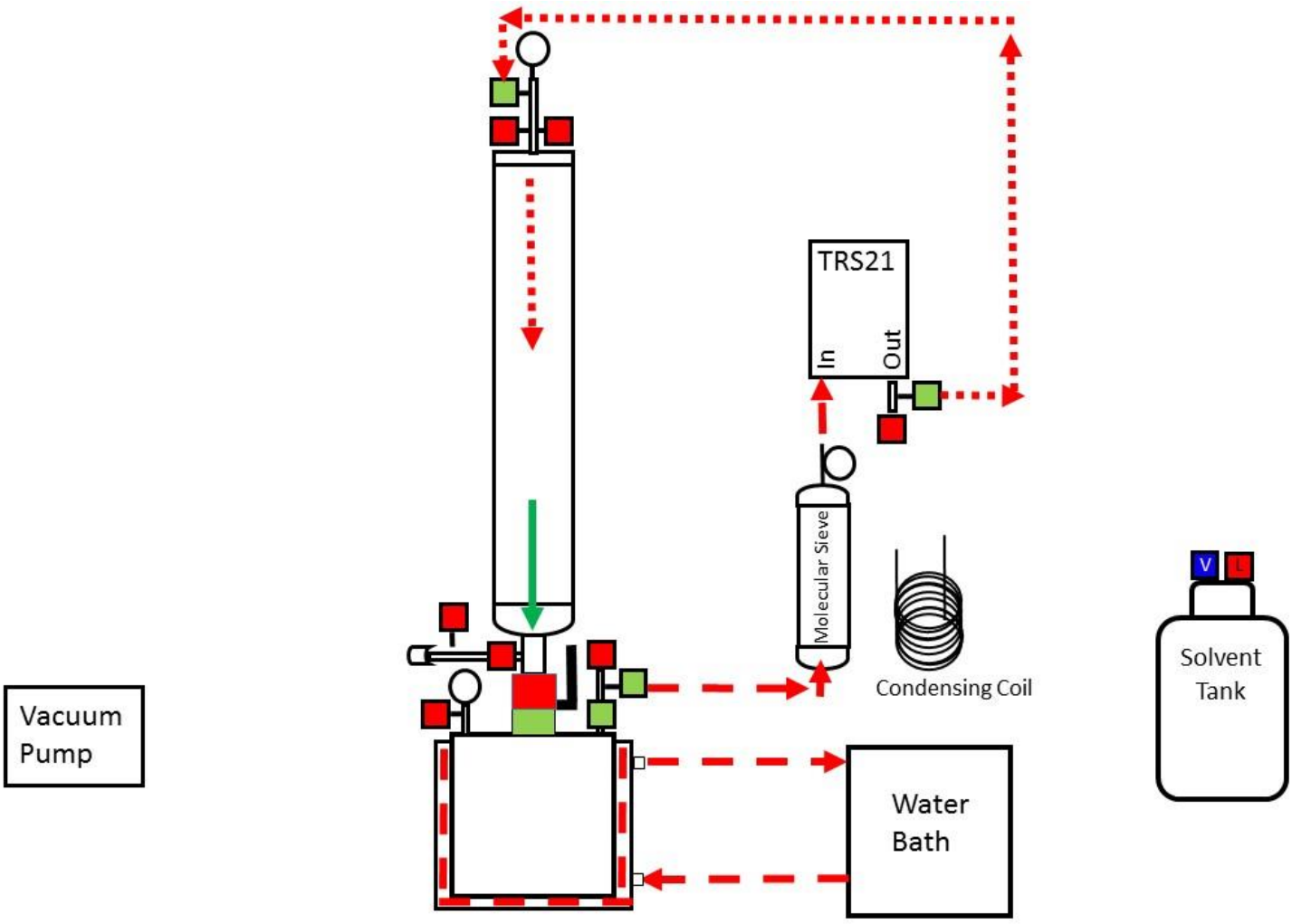



*FIG. 8*

The Mercurius Active system is set up to use a hot vapor loop to assist in clearing and recovering the material column. This is achieved by utilizing the heat created by the recovery pump, then bypassing the condensing coil to push hot vapors to the top of the material column.

As vapor initially enters the material column, the inline ball valve is to be closed. Warm vapors will visibly defrost the top portion of the column. As vapors defrost the top 1/3 of the column and pressures build, the inline ball valve is to be quickly opened to displace residual liquid solvent into the collection base.

After liquid is displaced, close the inline ball valve once more and allow the entire column to defrost. Pressures will rise in the column, which will prepare for column recovery.

**Recovery:**

Recovery is the distillation of the solvent in the collection chamber. By distilling, the impurities in the gas will be left behind (in this case, extract) as the gas moves to the LP tank.

In order to efficiently recover without damaging the extract, a few factors must be acknowledged.

First, we need to note the boiling point of the solvent. This must be noted as the LP tank must be chilled below this temperature. It is recommended to get the LP tank as cold as possible, as lower temperatures will ensure gas is instantly liquefied. Colder temperatures allow faster recoveries.

Second, the compounds being extracted must be acknowledged. It is important that the distillation temperature does not exceed the boiling point of the lowest boiling compound in the extract. In order to achieve a full extract, it is important that none of the extracted compounds are evaporated during distillation.
**Please refer to page 5 for information on boiling points in relation to vacuum level***

**Always perform regular tests and maintenance on recovery pump. It is highly recommended to set up a schedule of cleanings and rebuilds to ensure proper functionality.**

a. Column Recovery

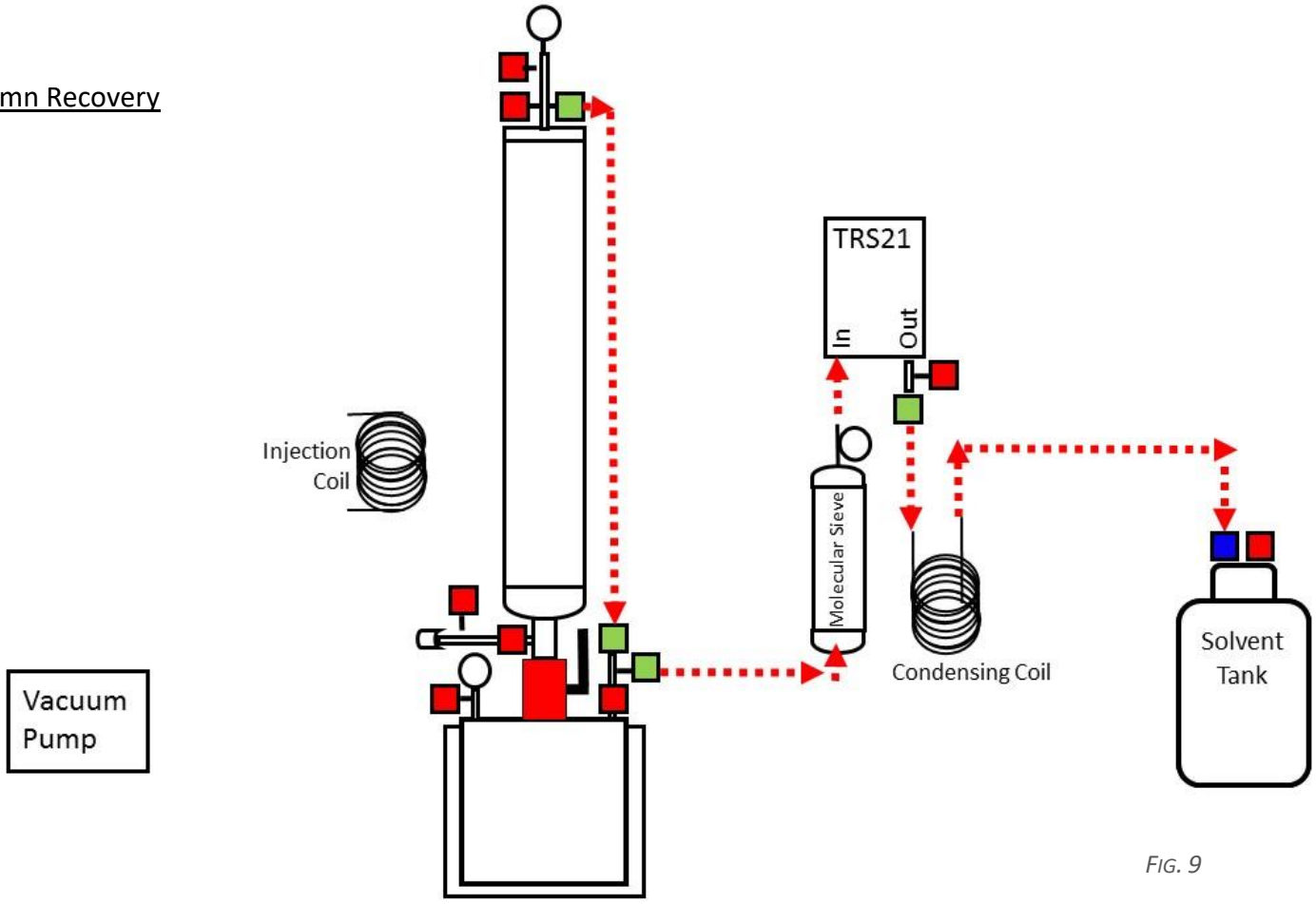



*FIG. 9*

It is recommended to start recovery on the column first. Make sure coil is submerged in a dry ice slurry. It is important to get the coil as cold as possible during the recovery. If dry ice is not available, an ice bath will work, however recovery times will be significantly increased.

If pump is not running, turn on recovery pump.

Open valves as show on previous diagram to allow the column to be recovered. In order to fully recover column, it is important to have used the hot vapor loop function to defrost and pressurize the column for recovery. Monitor column pressure to determine when recovery has finished. Recover until column reaches vacuum pressure.

b. Collection Base Recovery

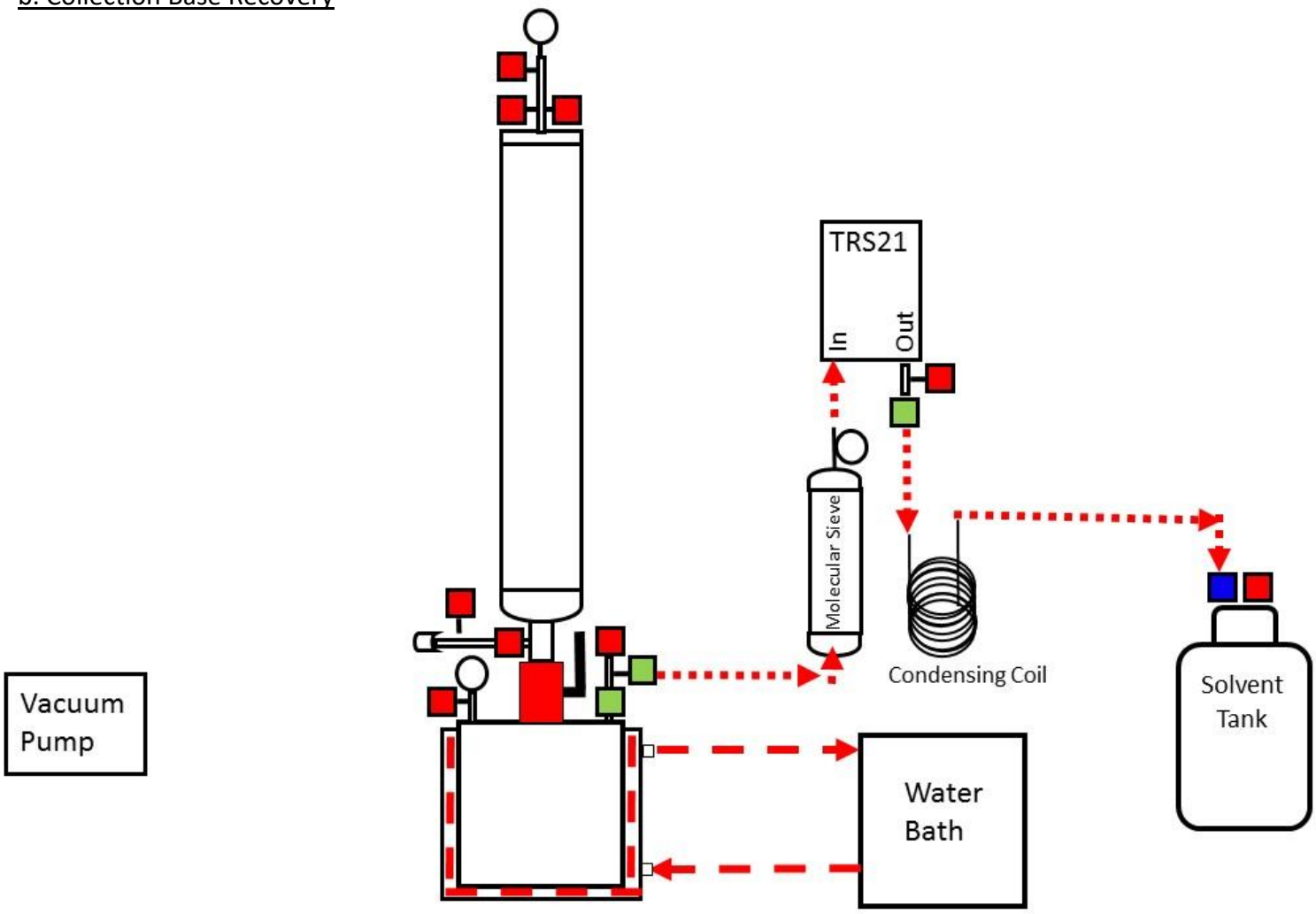



*FIG. 10*

Once column reaches vacuum pressure, reconfigure valves as shown above. Check temperatures in water bath. Target recovery temperature is ~100 F. Recovery progress can be monitored by sight windows and by solvent tank weight (prior to starting recovery, tare the solvent tank on a scale and monitor incoming solvent weight. Solvent should have been pre-weighed prior to starting extraction). It is recommended to

recover into a vacuum. This ensures that solvent vapors do not enter the work space when opening the collection base.

During this recovery, it is important to monitor temperatures of the coil bath and the heat bath. Add more dry ice as needed to maintain temperature. Failure to do so will result in longer recovery times and increased pressure in solvent tank.

c. When is Recovery Finished?

The easiest way to tell when recovery is finished is by checking the sight glasses on the collection base. This will show when the majority of the solvent is separated from the extract. This however, may not be the most accurate way to measure what percentage of solvent has been recovered.

The Mercurius Active is set up to recover 99% of solvent if operated correctly. By using both a pressure and weight measurement, you can accurately determine if this has been achieved. First, it is recommended to recover both the column and the base into negative pressure. This will ensure that the majority of the solvent has been removed from the system.

Second, weigh the solvent that has been recovered. The solvent should have been weighed prior to running the system. Prior to starting recovery, but after circulation has started in the condenser, tare the scale. You can now monitor the weight of solvent recovered. When both the gauges on the system read negative, and the weight inside the tank matches the starting weight, you have finished recovery. Close all valves and turn off pump.

**Post Run Procedure:**

Once recovery has finished, close recovery and LP valves, then shut down warm water circulation. It is recommended to allow recovery to happen until collection chamber hits negative pressure, ensuring that all gas has recovered.

Before the chamber can be opened, positive/negative pressure must be relieved. Open the vacuum valve to equalize pressure in collection chamber. Drain the jacket of warm water by removing supply hose from the input barb and allowing liquid to drain to the reservoir via the return hose. Once water is drained, the bottom platter of the collection chamber is ready to be removed. Carefully loosen each side of the clamp before removing.

**DO NOT LEAVE LIQUID SOLVENT IN COLLECTION CHAMBER. FAILURE TO FULLY RECOVER WILL EXPOSE ATMOSPHERE TO FLAMMABLE GAS.**

Removing the Extract:

After removing the collection base from the system, it is time to remove the extract. It is important that the utensil used to remove the extract is chemically compatible with the solvent used. A PTFE scraper is recommended. If using a metal scraper, avoid using excessive pressure and scratch the base.

Being that the base and extract should still be warm, the consistency should still be semi runny. Run the scraper in a circular motion from the outsides to the middle; the extract should pool in the center of the base. Scoop the extract out from center.

Cleaning and Gear Maintenance:

Once the extraction process is completed, it is important to break down and clean the gear. This will prevent contamination of future runs, as well as keep gaskets fresh. We recommend cleaning the gear with d-limonene, however isopropyl alcohol can be used. It is important to wipe gaskets clean rather than soak them in solvent. If using alcohol to clean gaskets, it is important to wipe them dry to prevent the gaskets from breaking down.

In between uses, it is recommended to keep lines connected and under vacuum. This prevents moisture and dust from getting into the system.

It is also recommended to empty the SS LP tank into a sealed IDOT approved storage container. Tanks with a clamp and gasket are not recommended for long term storage.

Always check chemical compatibility before using solvents to clean gaskets. Incompatible solvents will deteriorate gaskets and compromise seal. It is recommended to replace gaskets after heavy use.